

## 2.1

# Outline principles that define the biological level of analysis

### Principle 1: There are biological correlates of behaviour.

This means that there are physiological origins of behaviour such as neurotransmitters, hormones, specialized brain areas, and genes. The biological level of analysis is based on reductionism, which is the attempt to explain complex behaviour in terms of simple causes.

#### Principle 1 demonstrated in:

**Newcomer et al. (1999)** performed an experiment on the role of the stress hormone cortisol on verbal declarative memory. Group 1 (high dose cortisol) had tablets containing 160 mg of cortisol for four days. Group 2 (low dose cortisol) had tablets with 40 mg of cortisol for four days. Group 3 (control) had placebo tablets. Participants listened to a prose paragraph and had to recall it as a test of verbal declarative memory. This memory system is often negatively affected by the increased level of cortisol under long-term stress. The results showed that group 1 showed the worst performance on the memory test compared to group 2 and 3. The experiment shows that an increase in cortisol over a period has a negative effect on memory.

### Principle 2: Animal research can provide insight into human behaviour.

This means that researchers use animals to study physiological processes because it is assumed that most biological processes in non-human animals are the same as in humans. One important reason for using animals is that there is a lot of research where humans cannot be used for ethical reasons.

#### Principle 2 demonstrated in:

**Rosenzweig and Bennet (1972)** performed an experiment to study the role of environmental factors on brain plasticity using rats as participants. Group 1 was placed in an enriched environment with lots of toys. Group 2 was placed in a deprived environment with no toys. The rats spent 30 or 60 days in their respective environments before being killed. The brains of the rats in group 1 showed a thicker layer of neurons in the cortex compared to the deprived group. The study shows that the brain grows more neurons if stimulated.

### Principle 3: Human behaviour is, to some extent, genetically based.

This means that behaviour can, to some extent, be explained by genetic inheritance, although this is rarely the full explanation since genetic inheritance should be seen as genetic predisposition which can be affected by environmental factors.

- Researchers interested in the genetic origin of behaviour often use twins so that they can compare one twin with the other on a variable such as intelligence, depression or anorexia nervosa.
- Identical twins (monozygotic twins - MZ) are 100% genetically identical as they have developed from the same egg. They therefore act as a control for each other. Fraternal twins (dizygotic twins - DZ) have developed from two different eggs. They share around 50% of their genes so they are no more similar than siblings.
- Twin research never shows a 100% concordance rate so it is believed that genes are a predisposing factor rather than the cause of behaviour. Therefore it is also important to consider what environmental factors could influence the expression of the genetic predisposition.

#### Principle 3 demonstrated in:

**Bouchard et al. (1990)** performed the Minnesota twin study, a longitudinal study investigating the relative role of genes in IQ. The participants were MZ reared apart (MZA) and MZ reared together (MZT). The researchers found that MZT had a concordance rate of IQ of 86% compared to MZA with a concordance rate of IQ of 76%. This shows a link between genetic inheritance and intelligence but it does not rule out the role of the environment.

## Examine one study related to localization of function in the brain

### The case study of H.M.

- This case study is important because it provided evidence that there are different memory systems in the brain (see unit 3.3).
- **Milner (1957)** was the first to report the case of H.M. and the profound effects on memory functioning, following an operation which removed the hippocampus and adjacent areas in H.M.'s brain.
- **Corkin et al. (1997)** did a MRI scan of H.M.'s brain. Brain imaging was used because it allowed the researchers to get a precise picture of the brain damage. They discovered that parts of the temporal lobe, including the hippocampus and the amygdala, were missing, but also that the damage was not as extensive as previously believed.

H.M. suffered from epileptic seizures after he fell off a bike, aged seven. It was assumed that the seizures were connected to the accident and he became increasingly incapacitated.

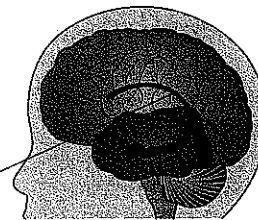
When H.M. was 27, the neurosurgeon William Scoville, performed experimental surgery in order to stop the seizures. Tissue from the medial temporal lobe, including the hippocampus, was removed on both sides of his brain.

After the operation H.M. suffered from amnesia. He could not create new episodic and semantic memories, but he was able to learn a few procedural memories. His personality remained unchanged and there was no general intellectual impairment.

This case study shows that the hippocampus is important in memory processing and particularly in the storage of new memories.

H.M. participated in research studies until his death in 2008, and his brain was donated to science.

The hippocampus



### What can be learned about localization of function in the brain in relation to memory from the case study of H.M?

- The hippocampus and the areas around the hippocampus play a critical role in converting memories of experiences from short-term memory (contemporary store) to long-term memory (permanent store).
- H.M. could retain memories of what had happened before the surgery. This indicates that the hippocampus is a temporary rather than a permanent memory store.
- H.M. could learn a few new procedural memories so this indicates that such memories are not stored via the hippocampus.
- The fact that H.M. (and other people with amnesia) had deficits in one part of the memory system but not in others is evidence that the brain has several memory systems and that these are supported by distinct brain regions.
- The study shows that memory processes are much more complex than originally believed. Although the hippocampus is very important in the storage of new memories it is not the only structure involved in the process.

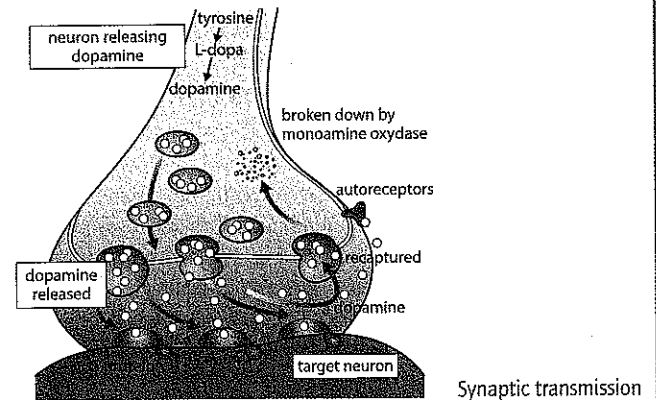
### Evaluation of the case study of H.M.

- The operation was based on the assumption that H.M.'s seizures would stop and it was successful in this respect, but the brain damage caused memory problems that had not been anticipated.
- H.M. participated in research for more than 50 years. He participated in many kinds of tests (e.g. cognitive tests, observations, and neuroimaging studies).
- This longitudinal case study has contributed enormously to the knowledge of how memory processes are related to specific brain areas, for example:
  - The medial temporal lobes are important for the forming, organization, consolidation, and retrieval of memories.
- Cortical areas are important for long-term memory, for facts and events (semantic and episodic memories), and the use of that information in daily life.
- Procedural memories are not processed by the hippocampus.
- There are ethical considerations in this case study. Since H.M. was not able to remember all the times he participated in research it could be argued that it was unethical. However, the findings of the study are very important and this justifies it.
- It is not usually possible to use the findings from a single case study to generalize about a larger population, but since the findings from other case studies of people with brain damage like H.M. tend to support those from this case study, it may be possible to generalize to some extent.

## 2.3

# Explain, using one or more examples, the effects of neurotransmission on human behaviour

- When a nerve impulse reaches the end of the neuron, the neuron fires and neurotransmitters are released into the synaptic gap where they travel to the neuron at the other side of the synaptic gap.
- If the neurotransmitter is not absorbed it can be re-uptaken, diffused out or destroyed. The neurotransmitter then binds to specific receptors at the other side. If a neurotransmitter is blocked or replaced (e.g. because another chemical interferes) then the messages change. This affects the physiological system, cognition, mood, or behaviour.



## Dopamine

Dopamine is a neurotransmitter involved in goal-directed behaviour (motivation) such as pleasure seeking, control of movement, emotional response, and addictive behaviour. Dopamine is released in the brain's reward system.

### Dopamine and addictive behaviour

- Dopamine is released in the brain's reward system and has been associated with pleasure seeking and addictive behaviour. Addictive drugs or substances increase the amount of dopamine in the reward system.
- Dopamine can be released by environmental triggers (e.g. the sight of a cigarette package, food, or a gambling machine) because this is associated with pleasure (reward).
- Nicotine is the psychoactive ingredient in tobacco, which increases the level of dopamine in the brain's reward circuit causing feelings of pleasure and relaxation.

### Berridge and Kringelbach (2009) on dopamine in pleasure seeking

fMRI scans were used to study brain areas involved in the subjective experience of pleasure. They found that the orbitofrontal cortex was active when people reported feeling pleasure.

The researchers concluded that dopamine and the nucleus accumbens is perhaps rather involved in *pleasure seeking*. This could explain addictive behaviour (e.g. nicotine addiction leads to craving).

The orbitofrontal cortex and natural opioids (endorphins) are perhaps linked to the subjective experience of pleasure.

### Fisher (2004) on dopamine in "addiction to love"

This is an evolutionary explanation of behaviour. "Being in love" has similarities with "being addicted" according to Fisher.

- Dopamine increases desire and reward by triggering the same emotional rush of pleasure when you see or think of the loved one as if you were taking a drug like cocaine.
- Dopamine can explain the highs of romantic passion (high levels of dopamine) and the lows of rejection (low levels of dopamine).

## Acetylcholine (ACh) on memory

- ACh is a neurotransmitter which has been linked to synaptic plasticity in the hippocampus and it seems to play an important role in learning and short-term memory via the cholinergic system (Shinoe et al. 2005).
- The cholinergic system is a system of nerve cells that uses acetylcholine in transmitting nerve signals. Memory processing and higher cognitive functioning are dependent on the cholinergic system.

Martinez and Kesner (1991) ACh in memory formation

**Aim** To investigate the role of ACh in memory formation

**Procedure** Experimental study using rats. They were trained to run a maze. They were divided into three groups.

- **Group 1:** received injection with scopolamine (blocks ACh

- **Group 2:** received injection with physostigmine (blocks production of cholinesterase (enzyme) which cleans up ACh from the synapses) leading to more available ACh.
- **Group 3:** The control group.

### Results

- **Group 1** had problems finding their way through the maze and made more mistakes.
- **Group 2** ran quickly through the maze and made few mistakes. The group was quicker than the control group.

### Evaluation

The study shows that ACh is important in memory since the rats showed different memory capacity depending on ACh level. Since this was a controlled laboratory experiment, it can be concluded that the level of ACh is one factor that affects memory but the neurobiology of memory is very complex.

# 2.4

## Explain, using examples, the function of two hormones on human behaviour

### Cortisol and memory

Cortisol is a hormone produced by the adrenal cortex in response to stress and to restore homeostasis (the body's normal balance). Chronic stress may result in prolonged cortisol

secretion and this can lead to physiological changes such as damaged immune system and impairment of learning and memory. This is because high amounts of cortisol results in atrophy of the hippocampus (Sapolsky, 1996).

Newcomer et al. (1999) Experiment on cortisol and memory

**Aim** To investigate how levels of cortisol interfere with verbal declarative memory.

**Procedure** A self-selected sample (recruited through advertisement) of 51 normal and healthy people aged 18-30 was used. It was a randomized, controlled, double-blind experiment running for four days. All participants gave informed consent. There were three experimental conditions: 1. A high level of cortisol (tablet of 160 mg per day), equivalent to cortisol levels in the blood as a consequence of a major stressful event. 2. A low level of cortisol (tablet of 40 mg per day), equivalent to cortisol

levels in the blood as a consequence of a minor stressful event. 3. A placebo (tablet of no active ingredient).

**Results** The high-level group performed worse on the verbal declarative memory test than the low-level group. They performed below placebo levels after day 1. The low-level group (mild stress) showed no memory decrease.

**Evaluation** This was a controlled randomized experiment so it was possible to establish a cause-effect relationship between levels of cortisol and scores on a verbal declarative memory test. Ethical issues were observed with informed consent. The negative effect of taking high dosages of cortisol was reversible so no harm was done.

### Oxytocin and trust

- ❑ The hormone oxytocin is secreted by the hypothalamus and released (1) into the blood stream via the pituitary gland or (2) into the brain and spinal cord where it binds to oxytocin receptors. Oxytocin acts primarily as a neurotransmitter in the brain.
- ❑ Oxytocin has been linked to trusting other people. Experimental manipulation of oxytocin levels has shown increase in trust.
- ❑ According to evolutionary psychologists, trust is an important social tool in the relationship between humans.

Trust is an adaptive mechanism as it helps humans to form meaningful relationships at a personal and professional level. Betrayal disrupts bonds of trust and may result in avoidance of the person who has betrayed you.

- ❑ Learning who to trust and who to avoid is important for survival and the well-being of an individual. Humans should also be able to move on after experiences of breaching trust if long-term relationships and mental well-being are to be preserved.
- ❑ Oxytocin could play a role in reducing fear reactions via the amygdala that may arise as a consequence of betrayal.

Baumgartner et al. (2008) The role of oxytocin in trust in economic behaviour

**Aim** To investigate the role of oxytocin after breaches of trust in a trust game.

**Procedure**

- ❑ The participants played a trust game used by economists and neuroscientists to study social interaction. The "investor" (player 1) receives a sum of money and must decide whether to keep it or share it with a "trustee" (player 2). If the sum is shared the sum is tripled. Then player 2 must decide if this sum should be shared (trust) or kept (violation of trust).
- ❑ fMRI scans were carried out on 49 participants. They received either oxytocin or placebo via a nasal spray.
- ❑ Participants played against different trustees in the trust game and against a computer in a risk game. In 50% of the games their trust was broken. They received feedback on this from the experimenters during the games.

**Results**

- ❑ Participants in the placebo group were likely to show less trust after feedback on betrayal. They invested less. Participants in the oxytocin group continued to invest at similar rates after receiving feedback on a breach of trust.
- ❑ The fMRI scans showed decreases in responses in the amygdala and the caudate nucleus. The amygdala is involved in emotional processing and has many oxytocin receptors. The caudate nucleus is associated with learning and memory and plays a role in reward-related responses and learning to trust.

**Evaluation**

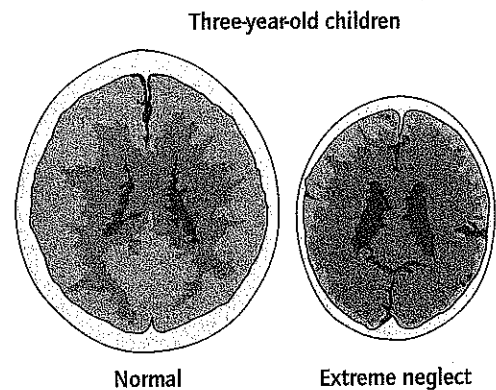
- ❑ Oxytocin could explain why people are able to restore trust and forgive in long-term relationships.
- ❑ Scanner research is merely mapping brain activity but nothing definite can be said about what it really means at this point in science.
- ❑ Giving oxytocin like this in an experiment may not reflect natural physiological processes. The function of oxytocin is very complex and it is too simplistic to say that it is "the trust hormone".

## 2.5

# Discuss two effects of the environment on physiological processes

### Effect 1: Environmental effects on dendritic branching (brain plasticity)

- Environmental stimulation refers to the way the environment provides stimulation in the form of social interaction and learning opportunities for animals and humans. Experiences are processed in the brain's nervous system, and stimulating environments will result in increased numbers of synapses (brain plasticity). Gopnick et al. (1999) describe neurons as growing telephone wires that communicate with each other.
- An enriched environment is characterized by multiple opportunities to learn new things. Researchers have used animal models to study synaptic changes in the brain because it is not possible to use humans in deprivation experiments.
- Instead researchers use case studies of children who have grown up in total neglect, i.e. with little or no experience of language, touch and interaction with other humans. The brains of neglected children are often smaller and there is scientific evidence of altered brain function (e.g. in intelligence and emotions)



Brain scans of brains of three-year-old children: normal brain and brain with signs of extreme neglect in a child (Perry, 1997).

Rosenzweig, Bennet and Diamond (1972) The role of environmental stimulation on brain plasticity

**Aim** To investigate whether environmental factors such as a rich or an impoverished environment affect development of neurons in the cerebral cortex.

#### Procedure

- Rats were placed in either an enriched environment (EC) or an impoverished condition (IC).
- EC: 10-12 rats in a cage provided with different stimulus objects to explore and play with. This group also received maze training.
- IC: each rat in an individual cage (isolation and no stimulation).
- The rats typically spent 30 to 60 days in their respective environments before they were killed so the researchers could study changes in brain anatomy.

#### Results

- The anatomy of the brain was different for rats in the EC and the IC.
- The brains of EC rats had increased thickness and higher weight of the cortex. EC rats had developed more acetylcholine receptors in the cerebral cortex (important neurotransmitter in learning and memory).

#### Evaluation

- The experiment was a rigorously controlled laboratory experiment so it was possible to establish a cause-effect relationship.
- The experiment used animal models and therefore it may be difficult to generalize to humans unless research with humans provides the same results.
- Follow-up of this research indicated that just 2 hours a day in an enriched environment produced the same plastic changes in the brain as in rats that had been constantly in the EC condition. This shows that the brain can change and adapt to new situations.
- Since brain plasticity is assumed to follow the same pattern in animals and humans the implications of the study are that the human brain will also be affected by environmental factors such as intellectual and social stimulation.
- The research challenged the belief that brain weight cannot change. This was an important finding.

There are ethical issues in the use of animals in research like this. Since the results contributed to a much better understanding of the role of environmental factors in brain plasticity it can be argued that the research was justified in spite of the ethical issues.

**Reference:** Rosenzweig, M.R., Bennet, E.L., and Diamond, M.C. (1972) 'Brain changes in response to experience', *Scientific American*, 226 (2) 22-29.

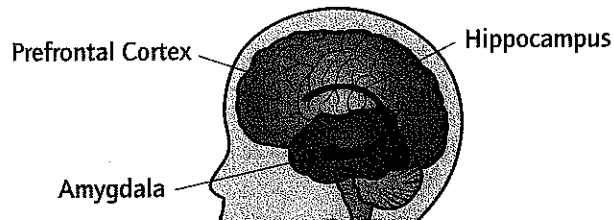


## Effect 2: Environmental stressors and hippocampal damage in PTSD patients

- A stressor is any event that threatens to disrupt the body's normal balance and starts a stress response such as secretion of stress hormones and activation of the 'fear sensor' in the brain, the amygdala.
- A stressor may be an acute stressor (e.g. being assaulted, having an accident) or it could be a chronic stressor (e.g. anticipation of violence or worrying).
- The fight or flight response (coping mechanism) is a pattern of physiological responses that prepares the body to deal with emergency. Sapolsky (1996) has shown in animal studies that long-term stress and a prolonged flow of cortisol can influence the size of the hippocampus, which plays a major role in memory.

### Trauma and PTSD

- Traumatic episodes (i.e. frightening situations from which a person cannot escape) produce intense fear. In about 5% of the population this may lead to PTSD (post-traumatic stress disorder) with effects that can last for a brief period or a lifetime.
- Combat veterans and survivors of childhood sexual abuse who suffer from PTSD tend to have a number of stress related problems such as forgetfulness and difficulty learning. In such patients stress-related physiological changes have been observed in the brain, especially in the hippocampus, which play an important role in integrating different aspects of a memory at the time of recollection.



Bremner et al. (2003) Stress, PTSD and memory problems related to reduction of hippocampal volume.

**Aim** To measure the volume of the hippocampus based on the theory that prolonged stress may reduce the volume of the hippocampus due to increased cortisol levels.

#### Procedure

- MRI scans were made of the brains of the participants and participants completed memory tests (e.g. remembering a story or a list of words).
- The participants were veterans and female adults who had experienced early childhood sexual abuse. Some had developed PTSD, but not all.

#### Results

- The researchers found that there were deficits in short-term memory and then performed MRI scans of the participants' brains.
- They found that the hippocampus was smaller in PTSD patients than in a control group. The veterans with most memory problems also had the smallest hippocampus.
- The findings showed a clear correlation between number of years of abuse as measured by a trauma test, memory problems and hippocampal volume.
- People suffering from PTSD often suffer from other psychological disorders (e.g. depression) which could perhaps also play a role in the observed changes in the brain.

#### Evaluation

- The sample was very small so it is difficult to say anything definite about the relationship between trauma and hippocampal volume.
- There could be alternative explanations to differences in hippocampal volume (e.g. that people who suffer from PTSD often suffer from depression as well). Depression is also associated with reduction of the hippocampus. However, the findings of a large reduction of hippocampal volume in combat-related PTSD has been replicated many times.

## 2.6

# Examine one interaction between cognition and physiology in terms of behaviour

- Cognitive neuroscience is the scientific study of biological correlates of mental processes (cognition). This area of research investigates how various brain areas are involved in cognitive processes (e.g. how brain damage affects memory), but in recent years researchers have also investigated how cognition and physiological processes may interact in people who meditate.
- A number of neuroscientists are examining how meditation or mindfulness-based stress reduction (MBSR) may influence brain functions (e.g. the effect of meditation on attention, emotional reactivity and stress).

- Interaction of cognition and physiology can be seen in the self-regulation of attention (MBSR) which seems to have physiological benefits (e.g. stress reduction).
- Interaction of cognition and physiology can be seen in the self-regulation of attention (MBSR) which seems to have physiological benefits (e.g. stress reduction).

### Davidson et al. (2004) Brain waves and compassion meditation

**Aim** To investigate whether meditation can change brain activity.

- Eight monks who had practised meditation for many years and a control group of 10 students who had one week of training participated in the study. Cognitive activities (including meditation) produce electrical activity when the neurons fire. This was recorded by the EEG (electroencephalograph which records electrical activity as brain waves).
- Participants were asked to meditate on 'unconditional compassion', i.e. open the mind for feelings of love and compassion for short periods.
- The control group participated in a training session where they were asked to think of someone they cared about and to let their mind be invaded by love and compassion.
- After initial training the participants were asked to generate an objective feeling of compassion without focusing on anyone in particular.
- The EEG of the monks' brains showed greater activation as well as better organization and coordination of gamma waves. There was a positive correlation between hours of practice and level of gamma waves.

#### Evaluation

- The results support the idea that attention and affective processes are skills that can be trained but more research is needed to establish if the change in brain waves is caused by hours of training and not individual differences before training.

Vestergaard-Poulsen et al. (2009) found that extensive practice of meditation involving sustained attention could lead to changes in brain structure. They found structural changes in the lower brain stem of participants engaged in long-term practice of meditation compared with age-matched non-meditators.

- MRI scans of two groups of participants – meditators and non-meditators.
- The study found structural changes in brain stem regions concerned with control of respiration and cardiac rhythm (autonomic nervous system). The connection of neurons in this area seemed more complex in people who meditated.
- This could explain some of the beneficial effects found in research on stress reduction techniques such as MBSR because cortisol levels are reduced and the cardiac and breathing rhythm slow down.
- Meditative practices have already been applied in health psychology, for example Davidson et al. (2003) found that Mindfulness meditation could increase positive emotion and immune responses.
- MBSR has also been found to alleviate pain (Grant et al. 2010).

See more on the application of MBSR in unit 7.5.

## Discuss the use of brain-imaging technologies in investigating the relationship between biological factors and behaviour

- Brain-imaging techniques are used in neuroscience to investigate the relationship between behaviour and brain structures, for example after brain damage or to find out which areas of the brain are involved in which cognitive activities (cognitive neuroscience).

- Brain-imaging technology is a promising way to investigate the possible relationship between biological factors and behaviour, but so far scanning can merely register structures and activity in the brain. It is not possible to determine cause-effect relationships at this point.

### MRI scan: magnetic resonance imaging

MRI scans can give detailed pictures of internal structures in the body. The body consists, to a large extent, of water molecules. In the MRI scanner a radio frequency transmitter is turned on and it produces an electromagnetic field.

#### Strengths of MRI

- MRI scans are particularly to show how the blood flows in the brain and can be used to identify problems with blood circulation. They can be used for the early detection of Alzheimers' disease.
- They are safe to use since no radioactive material is used.

#### Limitations of MRI

- They are very expensive.
- Movement may affect the pictures.
- They cannot say anything about cause-effect relationships.

Ashtari et al (2009) used MRI to investigate whether substance abuse (marijuana) can damage the developing brain in adolescents and young adults.

- The researchers scanned the brains of 14 young men with a history of heavy marijuana abuse over a long period. The control group consisted of 14 young men who had not used marijuana.
- The results of the scan indicated that there were brain abnormalities in the frontal, parietal and temporal regions of the brains of the marijuana users. The development of white matter (myelin) was affected and this could explain slow information processing in the brain.
- The researchers concluded that early marijuana use can affect brain development negatively but since the study gave correlational data more research is needed.

### fMRI scan: functional magnetic resonance imaging

The fMRI scanner measures changes in blood flow in the active brain. This is associated with use of oxygen and linked to neural activity during information processing. When participants are asked to perform a task, the scientists can observe the part of the brain that corresponds to that function. fMRI scanning is widely used by cognitive neuroscientists and other researchers and its use has increased enormously over the last 10 years.

#### Strengths of fMRI

- It does not use radioactive substances.
- It can record activity in all regions of the brain.

#### Limitations of fMRI

- The focus is mostly on localized functioning in the brain and does not take into account the distributed nature of processing in neural networks.
- The results are correlational so it is not possible to establish cause-effect relationships.

Harris and Fiske (2006) used fMRI scans to study students' brain processes as a response to being presented with pictures of extreme outgroups. This study in social cognition aimed to find the biological correlates of stereotypes and prejudice.

- The researchers scanned students while they were watching either pictures of different humans or objects. It was predicted that the medial prefrontal cortex would be active when participants looked at humans but not when they looked at objects.

- This was found except when participants looked at pictures of people from extreme outgroups such as the homeless and addicts. Brain regions related to 'disgust' were activated and there was no activity in the prefrontal cortex.
- The researchers concluded that this indicated a dehumanization of the outgroups. These groups were apparently viewed as 'disgusting objects' and not people.



## 2 Biological level of analysis

### General issues in brain imaging to consider in a discussion

- Brain imaging is mainly about mapping brain structures and activity in the brain.
- Another limitation deals with localization of function. It may be possible to identify brain structures that are active during a task but, since most structures are linked to other structures in networks, it is not possible at this point to say definitely where things happen in the brain.

### Exam Tip

If you are asked discuss the use of brain-imaging technologies you need to include at least two examples. If you are asked to discuss one, then don't mention more than one since you will receive no credit for mentioning more.

You can address "how and why specific technologies are used" and "strengths/limitations of using them" including research studies to support your argument. Although brain imaging is exciting as it offers a view into the living brain, it is still too soon to conclude anything definite about which areas are involved in what cognitive processes. The human brain is very complex and, at this point, brain imaging is perhaps best used in diagnosis of brain abnormalities.

## 2.8

## Discuss the extent to which genetics influences behaviour

### Gene mapping

Attempt to determine the effect of a particular gene on behaviour such as psychological traits (temperament), psychological disorders (e.g. depression or schizophrenia) or various physiological conditions.

Caspi et al. (2003) Longitudinal study on the possible role of the 5-HTT gene in depression after experiences of stressful events

- The 5-HTT gene influences the level of serotonin, which is known to play a role in controlling mood.
- The researchers compared participants with a normal 5-HTT gene and a mutation of the 5-HTT gene with shorter alleles. Both types are quite frequent in humans but the long allele is slightly more frequent (57%).
- The researchers found that participants who carried a mutation of the 5-HTT gene and who had experienced many stressful events were more likely to become depressed after stressful events than those participants who carried the normal 5-HTT gene.
- The 5-HTT gene could indicate a vulnerability to depression after stress and the researchers speculated whether the gene could moderate individual responses to environmental factors.

### Evaluation

- Since a large proportion of the population carries the mutation of the 5-HTT gene that makes them susceptible to depression after traumatic events, it can be difficult to conclude that the gene is a major contribution to depression. People who did not carry the mutation also became depressed.
- The study showed a correlation between the presence of a 5-HTT short allele and depression but it is not possible to establish a cause-effect relationship.
- Genes contribute to some extent to behavioural traits and disorders but it is not clear how environmental factors influence genes. Environmental factors were included in the study (stressful events) but there is no evidence against the idea that it could be the stressful events (environmental factors) that made people depressed.
- Much more research is needed before a clear relationship between a gene and a behavioural trait can be established

You could also use this study in unit 5.5 to discuss etiologies of abnormal behaviour. In this case a possible explanation of depression which could relate to the diathesis stress model.

## Twin studies

- Monozygotic twins (MZ or identical twins) come from the same egg and share 100% of their genes. Dizygotic twins (DZ or fraternal twins) come from two different eggs and share around 50% of their genes. Siblings share 50% of their genes.
- The researchers calculate concordance rate (the likelihood or probability that if one individual has the trait the other will also have it). The concordance rate is assumed to establish if or to what extent a certain trait is inherited.

- In twin studies, one twin acts as control for the other twin. The classic twin study only studied concordance rates and did not include environmental factors. In some cases MZ twins were raised apart and in these cases it was assumed that differences were due to environmental factors.
- In twin research, sets of MZ are compared with sets of DZ twins for a particular trait or disorder. High concordance rates in MZ twins and lower concordance rates in DZ twins for the same behaviour indicate that the trait or disease is linked to genes (inherited). Differences within pairs of identical twins are attributed to environmental factors.

## Bouchard et al. (1990) Twin study investigating genetic inheritance in intelligence

- This study used a self-selected sample of MZ twins who had been reared together (MZT) and MZ twins who had been reared apart (MZA) to investigate concordance rates for a number of variables such as IQ.
- The results showed that for IQ (measured by a standardized intelligence test called WAIS) the concordance rate was 69% for MZA and 88% for MZT.
- The researchers concluded that environmental factors do play a role in development of intelligence but IQ is to a large extent inherited and that 70% of the observed variation in the sample could be attributed to genetic variation.
- They claim that the results indicate that in a sample like the one in the study (white, middle-class in an industrialized

nation) genetic inheritance in IQ accounts for around two-thirds of the observed variance of IQ.

- They also said that their findings do not indicate that IQ cannot be increased, that is influenced by environmental factor.

### Evaluation

- Correlational data cannot establish cause-effect relationships.
- Concordance rates were high in the study but far from 100% so it was difficult to determine the relative influence of genes. Calculation of concordance rates is not always reliable.
- There was no control for the effect of environmental variables in the study and this affects accurate estimations of a genetic contribution to intelligence.
- The findings from this self-selected sample make it difficult to generalize findings.

## Problems in genetic research

Genetic research cannot at this point determine the extent to which genetic inheritance influence behaviour because:

- Genes interact with environmental factors in complex ways. It is difficult to measure relative influence of genes and environmental factors.
- Knowledge about genes is still limited.

- There are problems in genetic research (e.g. concordance rates in twin studies cannot say anything about cause-effect relationships). MZ twins being treated in the same way as DZ twins may be wrong (the "equal environment assumption" may be flawed) and this limits the possibility of drawing meaningful conclusions from twin studies.

# 2.9

## Examine one evolutionary explanation of behaviour

- The theory of evolution, suggested by Charles Darwin, is based on the assumption that living organisms face environmental challenges. Organisms that adapt the best have a greater chance of passing on their genes to the next generations.

- Organisms with specific genetic traits that enhance survival are said to be naturally selected. Natural selection is a crucial evolutionary process in Darwin's theory.

### One evolutionary explanation of behaviour: disgust in pregnant women

- Nausea and loss of appetite during pregnancy may have been evolved as a way to protect the mother and the fetus against diseases which could threaten the fetus. Disgust has evolved as a food-rejection response to prevent contamination and the spread of illness.
- The theory under investigation is whether disgust has evolved to compensate for the mother and the baby's vulnerability to disease during the first few months of pregnancy.

Fessler et al (2005) Elevated disgust sensitivity in the first trimester of pregnancy

**Aim** To investigate if disgust sensitivity in the first trimester of pregnancy was elevated as predicted.

#### Procedure

- A Web-based survey was completed by 691 women recruited through pregnancy-related Web sites. No compensation was offered for participation. The women's mean age was 28.1 years.
- On the Web-based questionnaire, the participants (1) indicated their current level of nausea using a 16-point scale and (2) answered questions to test their disgust sensitivity in eight different areas (e.g. food; contact with animals, body products, and dead animals; hygiene; contact with toilets).

#### Results

- Overall, disgust sensitivity related to food and body products in women in the first trimester was higher compared to those in the second and third trimesters.
- Disgust was particularly elevated in relation to food, which was exactly what the researchers had predicted.
- Food-borne diseases are particularly dangerous to women in the first trimester and therefore it was predicted that disgust sensitivity related to food would be high. This was supported by the results.
- The results may indicate that nausea and vomiting are evolved behaviour because they limit the likelihood that pregnant women will eat dangerous food.

#### Evaluation

- The data was collected through questionnaires. Self-reports may not be reliable. This is not an effective way of measuring disgust. It would have been more reliable to confront participants with real disgust-eliciting objects.
- The effect sizes were not big but significant. The findings are supported by other studies (e.g. Curtiss et al. 2004) showing that images that threaten the immune system are judged as more disgusting.

### Evaluation of evolutionary explanations

- It is difficult to test evolutionary theories and not much is known about the life of early humans.
- Evolutionary explanations tend to focus on biological factors and underestimate cultural influences.
- According to Davey (1974) disgust for spiders may be explained by people's need to find tangible causes of illness and disease when the causes were unclear.

See also the evolutionary explanation of the role of oxytocin in trust in unit 2.4.

#### Exam Tip

"Examine" means that you should consider whether this evolutionary theory can be supported or not. You should also explain general problems in evolutionary explanations.

## Ethical considerations in genetic research

There are specific issues of concern in genetic research within the biological level of analysis. This is particularly true in the search for genes involved in abnormal behaviour, but it is also relevant in research on genetic influence on disease, intelligence, personality, or health. The main reasons for concerns are:

- Knowledge about the role of specific genes in behaviour is still limited so researchers should be careful about making definite conclusions. Genetic research is often reductionist as it does not include environmental factors.
- Genetic research is correlational by nature so one should be careful to make definite conclusions about the risk of developing a disease.
- It is not certain that genetic research, like the Human Genome Project, is ethically neutral. There are historical examples of misuse of ethically sensible data (e.g. eugenics in Nazi Germany) and it is not guaranteed that data could not be misused again (Wallace 2004).
- Genetic research into complex behaviour such as homosexuality is controversial because of the social meaning and significance of homosexuality. Genetic research could result in stigmatization and discrimination as many societies are homophobic. The search for the "gay gene" has generally raised controversy.

Caspi et al. (2003) Longitudinal study on the possible role of the 5-HTT gene in depression after experiences of stressful events

- The researchers compared participants with a normal 5-HTT and a mutation of the 5-HTT gene with shorter alleles. Both types are quite frequent in the human population but the long allele is slightly more frequent (57%).
- The researchers found that participants who carried a mutation of the 5-HTT gene and who had experienced many stressful events were more likely to become depressed after stressful events than those participants who carried the normal 5-HTT gene.

### Conclusion

It is not clear what to do with knowledge from genetic research and genetic screening at this point – both at an individual level and in society. For example, being genetically predisposed to depression does not mean that a person will develop depression. The results of genetic screening for depression could cause personal distress and have a negative impact on someone's life (e.g. if based on this they decided not to have children).

## Ethical considerations in all genetic research

The DNA profile of each human is unique, except for MZ twins who are 100% genetically similar. The fact that one twin acts as a control in genetic research is the major reason why twins are often used to determine heritability. Genetic information is often seen as special because it is assumed that genes determine behaviour and genes are associated with personal identity. In reality, genetic information can only reveal a potential risk.

### Anonymity and confidentiality

- Participants in a genetic study must be sure that their anonymity and confidentiality is protected but in family and twin studies it can be difficult to ensure this fully. This is also the case in the research of rare disorders.
- Participants have a right to know who owns the genetic information and how it will be used in the future (e.g. if their access to insurance or employment could be compromised because of the genetic data).

### Informed consent and the right to refuse or withdraw

- Participants have a right to be fully informed about what the research is about, the procedures, what could be the result of the study and how the information will be used.
- Research into genetic influences on behaviour could potentially pose risks to participants and the genetic information could be misused.
- Genetic research can reveal information that is unexpected or a source of distress to participants (e.g. when a participant has no sign of a disorder but the data shows a genetic predisposition).